

APPENDIX A

Appendix A. Derivation of parameters μ^H and μ^L

In this appendix, the probabilities μ^H and μ^L (that the H-axis or L-axis is examined next when $i = D$) are derived when all cells having the same priority are equally likely to be selected for service (randomly selected).

Let \hat{P}^H (\hat{P}^L) denote the probability that the cell transmitted next when $i = D$ is an H-cell (L-cell). These probabilities are given by

$$\begin{aligned} \hat{P}^H &= \sum_{h=1}^{\infty} \sum_{l=0}^{\infty} \frac{h}{h+l} \Pr\{N^H = h, N^L = l\} = \sum_{h=1}^{\infty} \sum_{l=0}^{\infty} \frac{h}{h+l} (1-q^H)(q^H)^h (1-q^L)(q^L)^l \\ &\left(\hat{P}^L = \sum_{l=1}^{\infty} \sum_{h=0}^{\infty} \frac{l}{h+l} (1-q^H)(q^H)^h (1-q^L)(q^L)^l \right), \end{aligned} \quad (\text{A.1})$$

where N^H and N^L are denoted.

From the policy description, it is easy to establish that the class-selection probabilities μ^H and μ^L are related to the cell service probabilities \hat{P}^H and \hat{P}^L as follows:

$$\begin{aligned} \hat{P}^H &= \mu^H \Pr\{N^H > 0\} + \mu^L \Pr\{N^L = 0\} \Pr\{N^H > 0\} = \mu^H q^H + (1 - \mu^H)(1 - q^L)q^H, \\ \hat{P}^L &= \mu^L q^L + (1 - \mu^L)(1 - q^H)q^L. \end{aligned} \quad (\text{A.2})$$

From these equations, μ^H and μ^L can be derived as follows:

$$\mu^H = \frac{\hat{P}^H - (1 - q^L)q^H}{q^H q^L}, \quad \mu^L = \frac{\hat{P}^L - (1 - q^H)q^L}{q^H q^L}. \quad (\text{A.3})$$

The class-selection probabilities μ^H and μ^L can be alternatively set by considering arbitrary values for \hat{P}^H and \hat{P}^L instead of the values given by (A.1).

APPENDIX B**Appendix B. Equations in Case B: $T^L < T^H$.***Case B.1. $T^L \geq j > 0, \min(T^L - j, D + 1) \geq i \geq m$.*1. $i < D$:

$$\begin{aligned} Y^H(i, j) &= I^H + Y^H([i + \hat{I}^H, j - 2\hat{I}^H + 1]^*), \\ Y^L(i, j) &= Y^L([i + \hat{I}^H, j - 2\hat{I}^H + 1]^*). \end{aligned} \quad (\text{B.1})$$

2. $i = D + 1$:

$$\begin{aligned} Y^H(D + 1, j) &= Y^H([i - \hat{I}^L, j - \hat{I}^L + 1]^*), \\ Y^L(D + 1, j) &= I^L + Y^L([i - \hat{I}^L, j - \hat{I}^L + 1]^*). \end{aligned} \quad (\text{B.2})$$

3. $i = D$

$$\begin{aligned} Y^H(D, j) &= \{I^H + Y^H([i + \hat{I}^H, j - 2\hat{I}^H + 1]^*)\}I_{\{H\}} + Y^H([i - \hat{I}^L, j - \hat{I}^L + 1]^*)I_{\{L\}}, \\ Y^L(D, j) &= Y^L([i + \hat{I}^H, j - 2\hat{I}^H + 1]^*)I_{\{H\}} + \{I^L + Y^L([i - \hat{I}^L, j - \hat{I}^L + 1]^*)\}I_{\{L\}}. \end{aligned} \quad (\text{B.3})$$

Case B.2. $T^H > j > T^L, i = T^L - j$.

$$\begin{aligned} Y^H(i, j) &= I^H + Y^H([i + \hat{I}^H, j - 2\hat{I}^H + 1]^*), \\ Y^L(i, j) &= Y^L([i + \hat{I}^H, j - 2\hat{I}^H + 1]^*). \end{aligned} \quad (\text{B.4})$$

Case B.3. $j = T^H, i = T^L - T^H$.

$$Y^H(i, T^H) = I^H + Y^H([i + 1, T^H - \hat{I}^H]^*), \quad Y^L(i, T^H) = Y^L([i + 1, T^H - \hat{I}^H]^*). \quad (\text{B.5})$$

Case B.4. $j = 0, \min(T^L, D + 1) \geq i \geq 1$.

$$Y^H(i, 0) = Y^H([i - \hat{I}^L, 1 - \hat{I}^L]^*), \quad Y^L(i, 0) = I^L + Y^L([i - \hat{I}^L, 1 - \hat{I}^L]^*). \quad (\text{B.6})$$

In Case B.3, i may be less than 0.

APPENDIX C

Appendix C. The systems of linear equations

Case A. $T^L \geq T^H$.

$$\bar{Y}^H(0, 0) = 0, \quad \bar{Y}^L(0, 0) = 0. \quad (C.1)$$

By taking expectation operation on both sides of Eqs. (5)–(12), the following are obtained:

Case A.1. $T^H > j > 0, \min(T^L - j, D + 1) \geq i \geq m$.

$$\tilde{i} = \begin{cases} i & \text{if } i + j < T^L, \\ i - 1 & \text{if } i + j = T^L. \end{cases}$$

1. $i < D$:

$$\begin{aligned} \bar{Y}^H(i, j) &= q^H + (1 - q^H)\bar{Y}^H(i + 1, j - 1) + q^H\bar{Y}^H(\tilde{i}, j + 1), \\ \bar{Y}^L(i, j) &= (1 - q^H)\bar{Y}^L(i + 1, j - 1) + q^H\bar{Y}^L(\tilde{i}, j + 1). \end{aligned} \quad (C.2)$$

2. $i = D + 1$:

$$\begin{aligned} \bar{Y}^H(D + 1, j) &= (1 - q^L)\bar{Y}^H(i - 1, j) + q^L\bar{Y}^H(\tilde{i}, j + 1), \\ \bar{Y}^L(D + 1, j) &= q^L + (1 - q^L)\bar{Y}^L(i - 1, j) + q^L\bar{Y}^L(\tilde{i}, j + 1). \end{aligned} \quad (C.3)$$

3. $i = D$:

$$\begin{aligned} \bar{Y}^H(D, j) &= \mu^H q^H + \mu^H(1 - q^H)\bar{Y}^H(i + 1, j - 1) + \mu^L(1 - q^L)\bar{Y}^H(i - 1, j) \\ &\quad + (\mu^H q^H + \mu^L q^L)\bar{Y}^H(\tilde{i}, j + 1), \\ \bar{Y}^L(D, j) &= \mu^L q^L + \mu^L(1 - q^L)\bar{Y}^L(i - 1, j) + \mu^H(1 - q^H)\bar{Y}^L(i + 1, j - 1) \\ &\quad + (\mu^H q^H + \mu^L q^L)\bar{Y}^L(\tilde{i}, j + 1). \end{aligned} \quad (C.4)$$

Case A.2. $j = T^H, T^L - T^H \geq i \geq m$.

$$\tilde{i} = \begin{cases} i + 1 & \text{if } i + T^H < T^L, \\ i & \text{if } i + T^H = T^L. \end{cases}$$

1. $i < D$:

$$\begin{aligned} \bar{Y}^H(i, T^H) &= q^H + (1 - q^H)\bar{Y}^H(i + 1, T^H - 1) + q^H\bar{Y}^H(\tilde{i}, T^H), \\ \bar{Y}^L(i, T^H) &= (1 - q^H)\bar{Y}^L(i + 1, T^H - 1) + q^H\bar{Y}^L(\tilde{i}, T^H). \end{aligned} \quad (C.5)$$

2. $i \geq D + 1$:

$$\begin{aligned}\bar{Y}^H(i, T^H) &= (1 - q^L)\bar{Y}^H(i - 1, T^H) + q^L\bar{Y}^H(\tilde{i}, T^H), \\ \bar{Y}^L(i, T^H) &= q^L + (1 - q^L)\bar{Y}^L(i - 1, T^H) + q^L\bar{Y}^L(\tilde{i}, T^H).\end{aligned}\tag{C.6}$$

3. $i = D$:

$$\begin{aligned}\bar{Y}^H(D, T^H) &= \mu^H q^H + \mu^H(1 - q^H)\bar{Y}^H(i + 1, T^H - 1) + \mu^L(1 - q^L)\bar{Y}^H(i - 1, T^H) \\ &\quad + (q^H \mu^H + q^L \mu^L)\bar{Y}^H(\tilde{i}, T^H), \\ \bar{Y}^L(D, T^H) &= \mu^L q^L + \mu^H(1 - q^H)\bar{Y}^L(i + 1, T^H - 1) + \mu^L(1 - q^L)\bar{Y}^L(i - 1, T^H) \\ &\quad + (q^H \mu^H + q^L \mu^L)\bar{Y}^L(\tilde{i}, T^H).\end{aligned}\tag{C.7}$$

Case A.3 . $j = 0, \min(T^L, D + 1) \geq i \geq 1$.

$$\tilde{i} = \begin{cases} i & \text{if } i < T^L, \\ i - 1 & \text{if } i = T^L. \end{cases}$$

$$\begin{aligned}\bar{Y}^H(i, 0) &= (1 - q^L)\bar{Y}^H(i - 1, 0) + q^L\bar{Y}^H(\tilde{i}, 1), \\ \bar{Y}^L(i, 0) &= q^L + (1 - q^L)\bar{Y}^L(i - 1, 0) + q^L\bar{Y}^L(\tilde{i}, 1).\end{aligned}\tag{C.8}$$